STRAIN-FRACTURES OF THE KNEE.

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The Röntgen era has brought to light many strange and hitherto unsuspected types of fractures.

Many of these recently discovered fractures are of the indirect variety, that is, fractures due to ligamentous or muscular strain rather than to direct violence. Such fractures were formerly diagnosed and treated as " sprains." To-day the diagnosis of " sprain " is justifiable only after a Röntgen examination has shown the absence of a fracture.

The most familiar type of fracture from ligamentous strain (indirect violence) is the Colles' fracture of the wrist. It is the purpose of these few lines to call attention to a type of fracture of the knee-joint produced in an analogous manner.

A glance at the anatomical make-up of the knee-joint establishes at once the possibility and plausibility for the occurrence of indirect or ligamentous strain fractures. The knee-joint is one of the most superficial and as far as adaptation of the bony surfaces goes, one of the weakest joints in the body, for in no position are the bones in more than partial contact. Its strength lies in the number, size and arrangement of the ligaments and the fascial expansions which pass over the articulation and enable it to withstand the leverage of the two longest bones in the body.

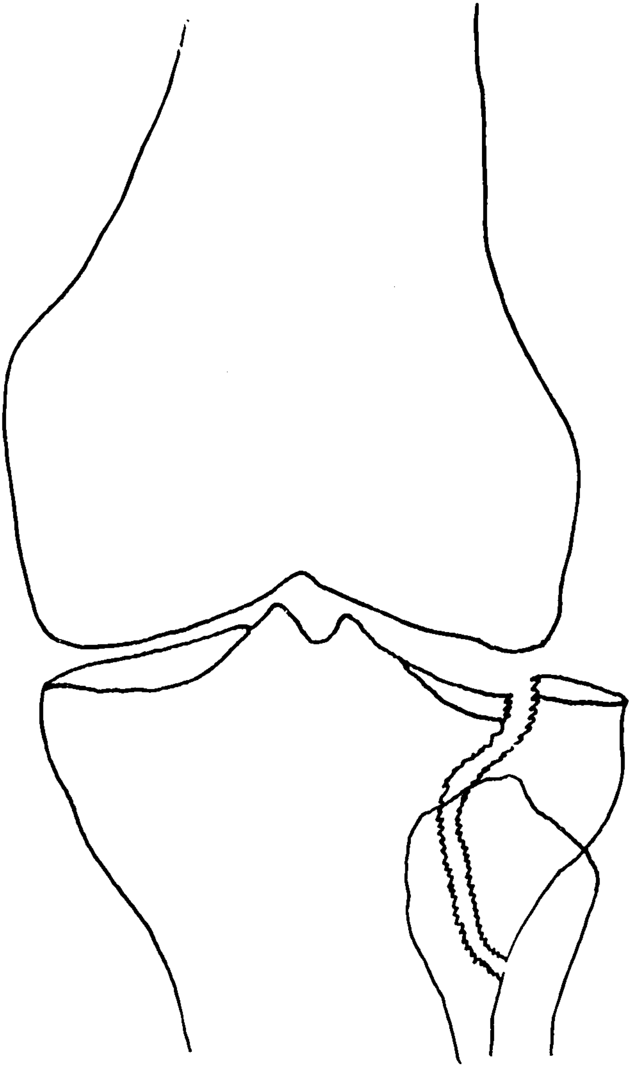
The strongest and most important of the ligaments that unite the two component bones of the knee-joint are: (*a*) patellar ligament, (*b*)internal lateral ligament, (*c*) external lateral ligament, (*d*) posterior ligament, (*e*) crucial ligaments,—anterior and posterior.

The patellar ligament is tense in flexion, relaxed in extension. Acting in conjunction with the anterior portion of the joint capsule, it limits excessive flexion. Sudden strain in partial flexion frequently results in transverse or indirect fracture of the patella. The internal lateral ligament extends from the internal condyle of the femur to the shaft of the tibia below the inner tuberosity. It is tense during extension but relaxed during flexion. The external lateral is attached above to the external condyle of the femur. Below it divides into two portions, one of which is attached to the head of the fibula, while the smaller posterior portion joins the strong posterior ligament, to be attached to the outer tuberosity of the tibia. Like the internal, the external lateral ligament is tense during extension but relaxed in flexion. The lateral ligaments withstand the lateral strains upon the joint. They also check hyperextension and outward rotation.

The posterior ligament bounds the popliteal aspect of the joint and limits extension. The crucial ligaments play the most important part in maintaining the integrity of the knee-joint. The anterior crucial ligament is attached to the fossa in front of the spine of the tibia and to the anterior part of the ridge which separates the inner and outer tibial articular facets and is closely connected with the anterior end of the internal semilunar cartilage. The posterior crucial ligament arises from the fossa behind the tibial spine as well as from the space between the two tubercles which go to make up the tibial spine. It receives fibres from the posterior ligament and from the external semilunar cartilage. The crucial ligaments are inserted above to the mesial aspects of the inner and outer femoral condyles. They are more or less tense in all positions of the knee-joint, with the possible exception of flexion. They limit extension and (the anterior crucial) inward rotation. In conjunction with the lateral ligaments they prevent forward and backward sliding motions. Their function in flexion is somewhat unsettled. Treves insists that they become tense in flexion and thus limit over-flexion.

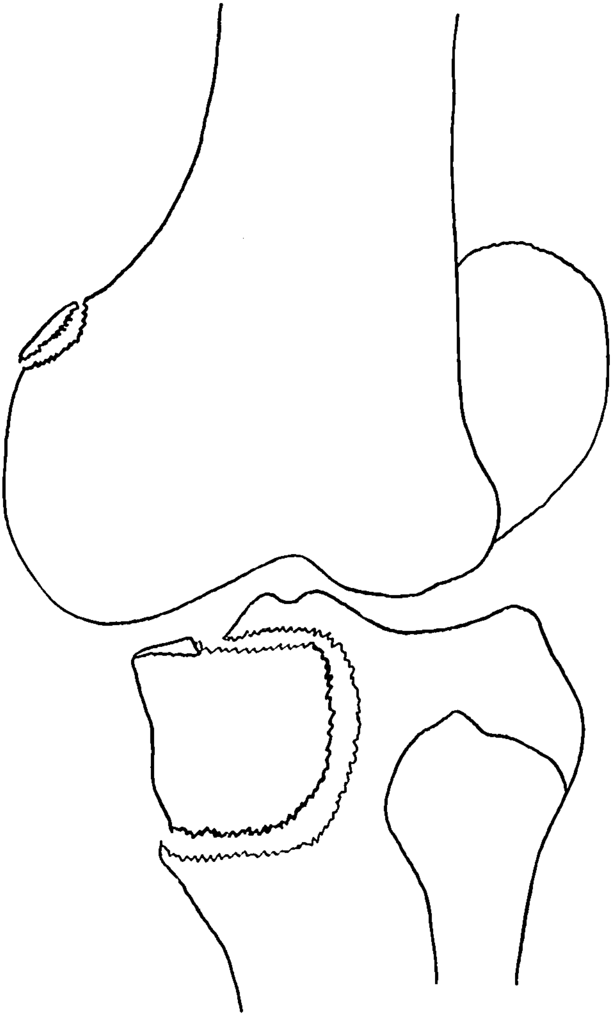
In studying the effects of strain upon the knee-joint in various directions, we may dismiss at once the flexion strain against the resistance of the patellar ligament and its subtended muscles, for we are well acquainted with the transverse

FIG. 1.



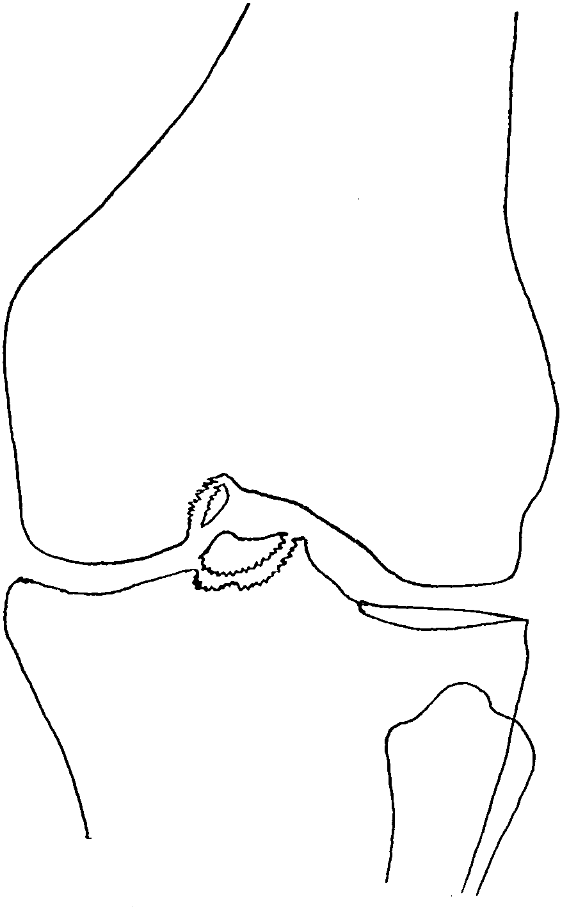
Avulsion of external tuberosity of tibia. Outline from a skiagraph.

FIG. 2



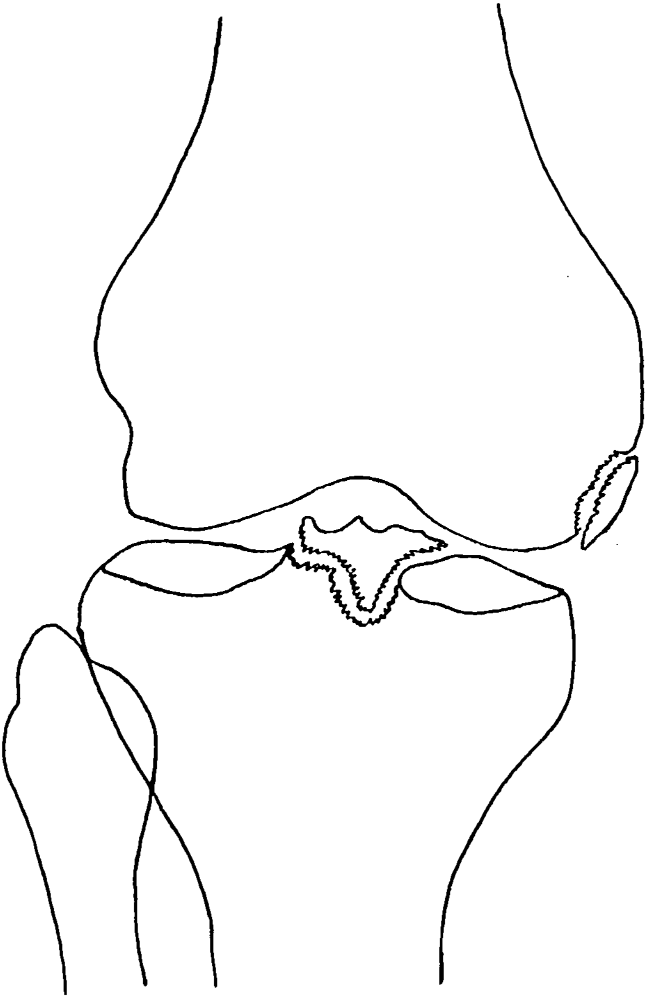
Avulsion of fragment from the internal tuberosity of head of tibia with tearing off of small scale from internal tuberosity of the femur. Outline from a skiagraph.

Fig. 3



Crucial ligament fractures. Outline from a skiagraph.

FIG. 4.



Crucial ligament fracture; with tearing away of scale at insertion of internal ligament into femur. Outline from a skiagraph.

patella fractures which most commonly follow such violence.

We have then to consider:

(*a*) Strain in the direction of hyperextension against the crucials, the posterior and the lateral ligaments;

(*b*) Strain exerted laterally against the internal or external lateral ligaments, the knee being in extended position, which puts these ligaments on the stretch;

(*c*) Strain in a rotatory direction, either in the direction of outward rotation, which is normally limited by the lateral ligaments, or in the direction of inward rotation, which is normally limited by the anterior crucial ligament.

It should be understood that the above scheme is arranged simply for the purpose of discussion and that in any given case the strain will be exerted in several directions simultaneously.

The following four cases served to call the writer's attention to the frequency of strain-fractures about the knee.

CASE I (from the service of Dr. J. C. Oliver).—Mr. C. W. K. While attempting to board a moving street car, the patient missed the car step, " twisted his knee," and fell to the ground. He at once arose, experiencing only slight pain in his knee (right) and walked six squares when the pain became so intense that he was compelled to sit down in a neighboring drug store, whence he was removed to the Cincinnati Hospital. *Examination of the knee showed no evidence of direct trauma to the soft parts.* A skiagraph (sketch 1) showed a tearing off of the *external* tuberosity of the tibia, the line of fracture running into the knee-joint.

CASE II (from the service of Dr. J. C. Oliver).—Mr. C L. Patient was injured in a street car accident. The left femur was fractured about two inches above the knee. *The right knee showed no evidence of direct trauma* and exhibited no positive signs of fracture of its component bones, but the severe pain on manipulating the joint suggested the need for a Röntgen examination. The skiagram revealed a tearing off of the *internal* tuberosity of the tibia as well as a small fragment off the internal condyle of the femur, evidently a strain-fracture (sketch 2).

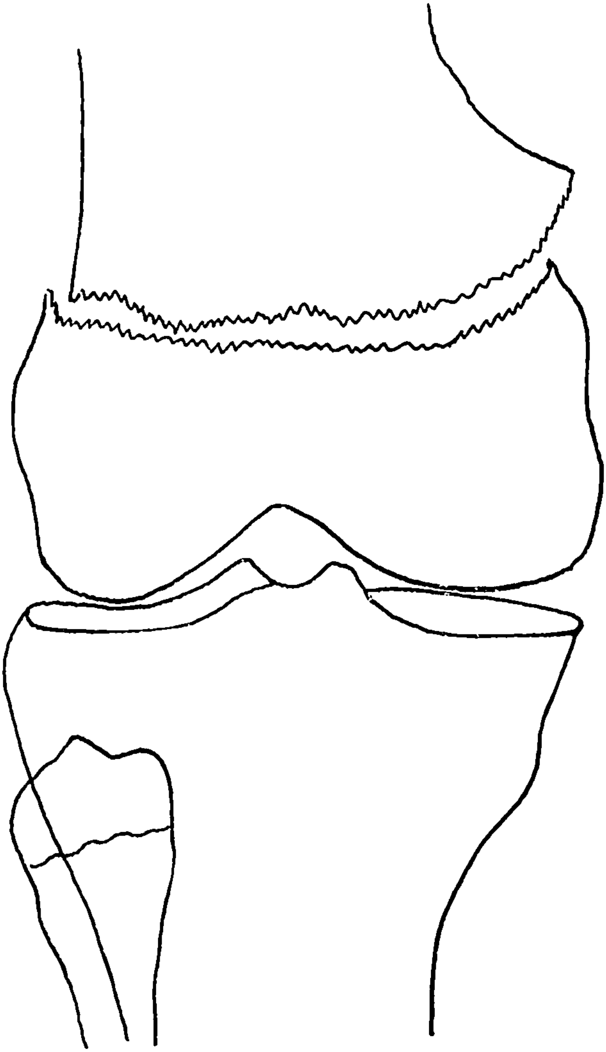
CASE III (from the service of Dr. C. E. Caldwell).—Mr. McD. while wrestling accidentally twisted his left knee and fell to the floor. He experienced great pain in the knee-joint but was able to walk to the hospital. Physical examination revealed a somewhat enlarged thickened joint but gave no positive evidence of fracture. A skiagram revealed a tearing off of the tibial spines (sketch 3).

Case IV (from the service of Dr. Jos. Ransohoff).—Mr. J. D. while attempting to alight from a moving street car, twisted his left knee and was thrown violently to the ground. He was unable to arise, owing to the great pain in his knee. Physical examination showed *no bruising of the soft parts* nor evidence of fracture. A skiagram showed a tearing off of the internal condyle of the femur and an avulsion of the tibial spine (sketch 4).

In the above-cited four cases of fracture about the knee we have a history of a sudden and severe strain to the knee-joint with, upon physical examination, no evidence or bruising of the soft parts nor any of the usual signs of fracture. In Case I we may assume a lateral strain upon the knee from within outward, putting the *external* lateral ligament on the stretch, and then causing a tearing off of its tibial attachment (the *external* tuberosity of the tibia). In Case II we may assume strain in the opposite direction, which was exerted chiefly upon the *internal* lateral ligament, resulting in a tearing off of its tibial attachment (the *internal* tuberosity of the tibia) and also loosening a small fragment at the site of its femoral attachment (the internal condyle of the femur). In Case III the strain was borne chiefly by the crucial ligaments, resulting in an avulsion of the tibial spines at their base. In Case IV the strain was apparently felt first by the internal lateral ligament, which resulted in a tearing off of its femoral attachment (the internal condyle of the femur). This giving way of the internal lateral ligament apparently put the crucial ligaments on the stretch as evidenced by the avulsion of their tibial attachment (the tibial spine).

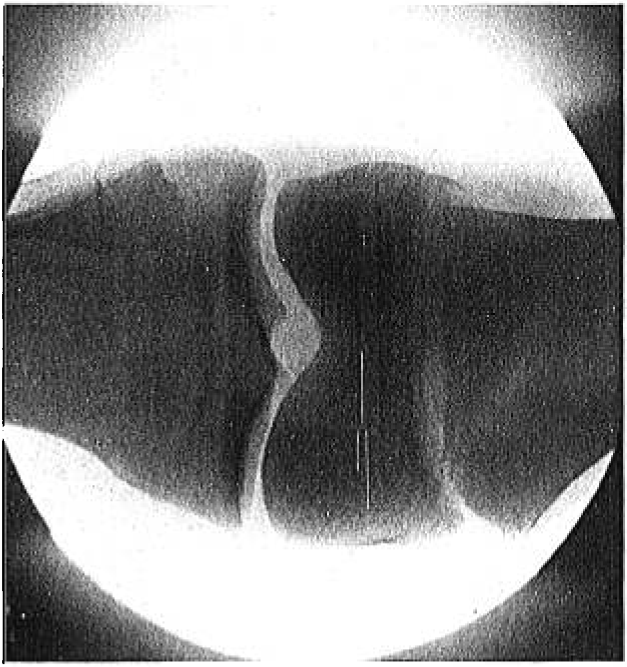
In studying the effect of knee strain by experimenting upon the cadaver, still another type of fracture by indirect trauma was brought to light. Figure 5, sketch 5, shows the result of lateral and postero-anterior strain upon the knee of

FIG. 5.



Epiphyseal separation at lower end of femur. Outline from a skiagraph (Fig. 6).

Fig. 6.



Skiagraph of epiphyseal avulsion at lower end of femur.

the cadaver of a young adult. It consists in a complete epiphyseal separation of the lower end of the femur. It was produced by placing the cadaver in a ventrolateral position and bending the knee over the edge of the table.

It is more than probable that such a fracture may be produced in the living in an analogous manner.

The close relation between the crucial ligaments and semilunar cartilages (anterior crucial with internal semilunar and posterior crucial with external semilunar) indicates that strains upon the crucial ligaments will be felt by the semilunar cartilages and that dislocations of the semilunar cartilages may be accompanied by strain-fractures of the above-described type and vice versa.

Routine Röntgen examination of injured knee-joints will undoubtedly show strain-fractures of the component bones to be relatively frequent. The well-executed skiagram will render possible an accurate diagnosis of conditions that are too often vaguely termed " internal derangements of the knee-joint."